Geocoding for all: A subtle introduction to Geocoding

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Agenda

I. What is Geocoding?
II. Geocode as
    1. a Novice
    2. an Advanced Beginner
    3. a Competent
    4. a Proficient
    5. an Expert
III. Reverse geocoding in QGIS
IV. Time to try geocoding in QGIS
V. Time to try geocoding with GeoPy

Unfortunately not covered today

- The history of geocoding
- Comparison of geocoders
- Geocoding algorithms
- Fuzzy logic
- Apache Solr, ElasticSearch
- Data Science and Machine Learning
- Levenshtein distance
- Geocoding in Data Bases
- Coordinate Systems and Transformations
- OpenStreetMap Philosophy
- Setting an API key for a Geocoding API
- File data types, encodings, and extensions
- Python Essentials
- Installation of Packages in Python
- The concept of requests on the Internet
- Proxy, certificate, SSL, TLS, HTTP/HTTPS

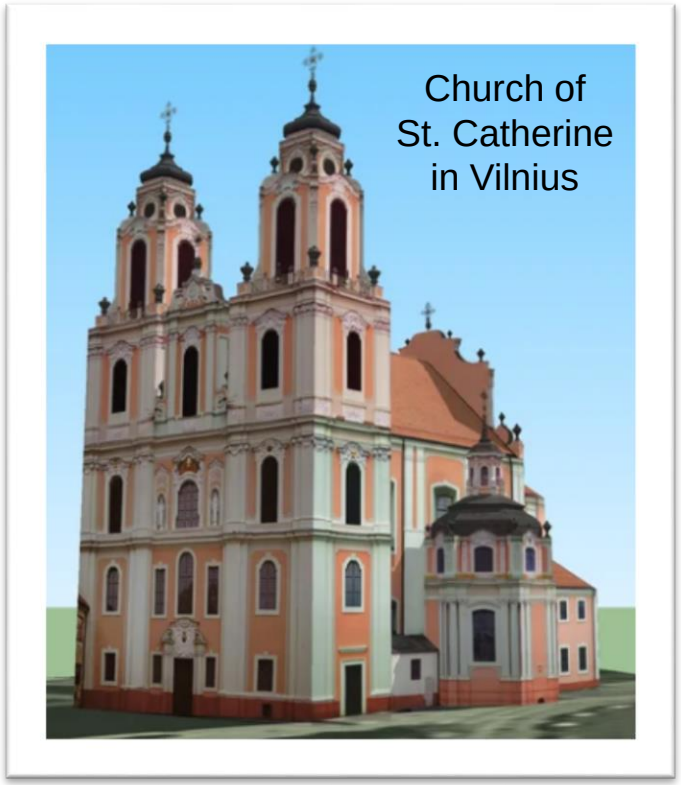
I. What is Geocoding?

Vilniaus g. 30,
Vilnius 01119,
Lithuania

Geocoding is a process of finding geographic coordinates for a physical (mailing) address.

A coordinates pair serves to identify a location on the Earth's surface.

synonyms :
Forward geocoding,
Address geocoding



Reverse geocoding is the process of converting coordinates to a human-readable address or place name.

Addresses provide a means of physically locating a building. It differs by country and area.

synonyms :
Backward geocoding,
Inverse geocoding

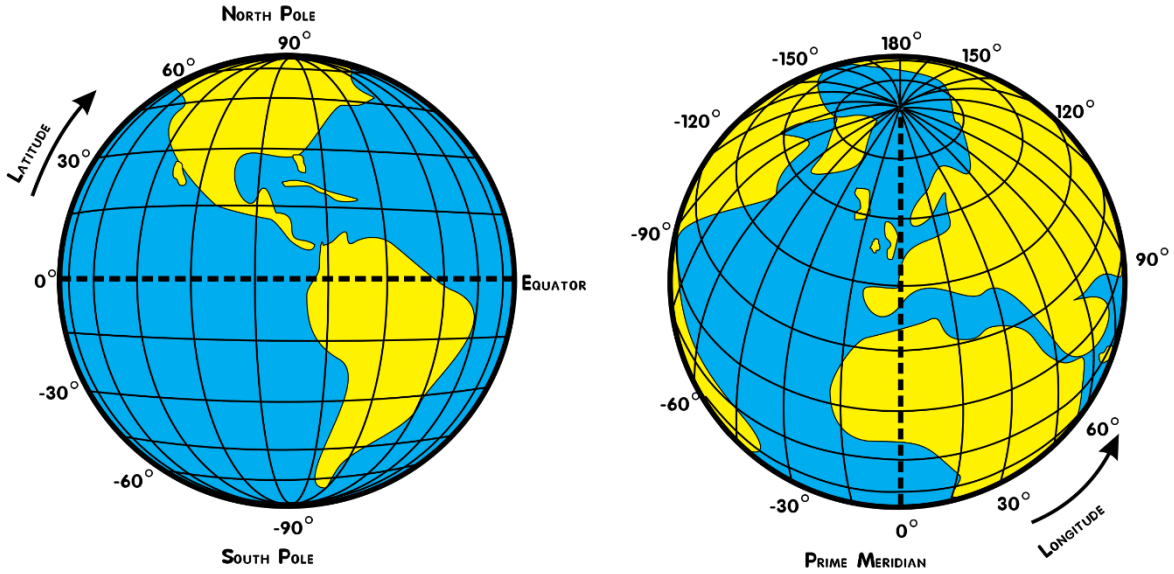
Latitude : 54.681778
Longitude : 25.281222

https://en.wikipedia.org/wiki/Church_of_St._Catherine,_Vilnius accessed 21.04.2022

I. What is Geocoding?

Each address may (or may not) lead to a point (or several points) with latitude/y, longitude/x coordinates in decimal format.

All returned coordinates use WGS 84 (sometimes set as EPSG:4326 (https://epsg.org/crs_4326/WGS-84.html)) as Reference Coordinate System.



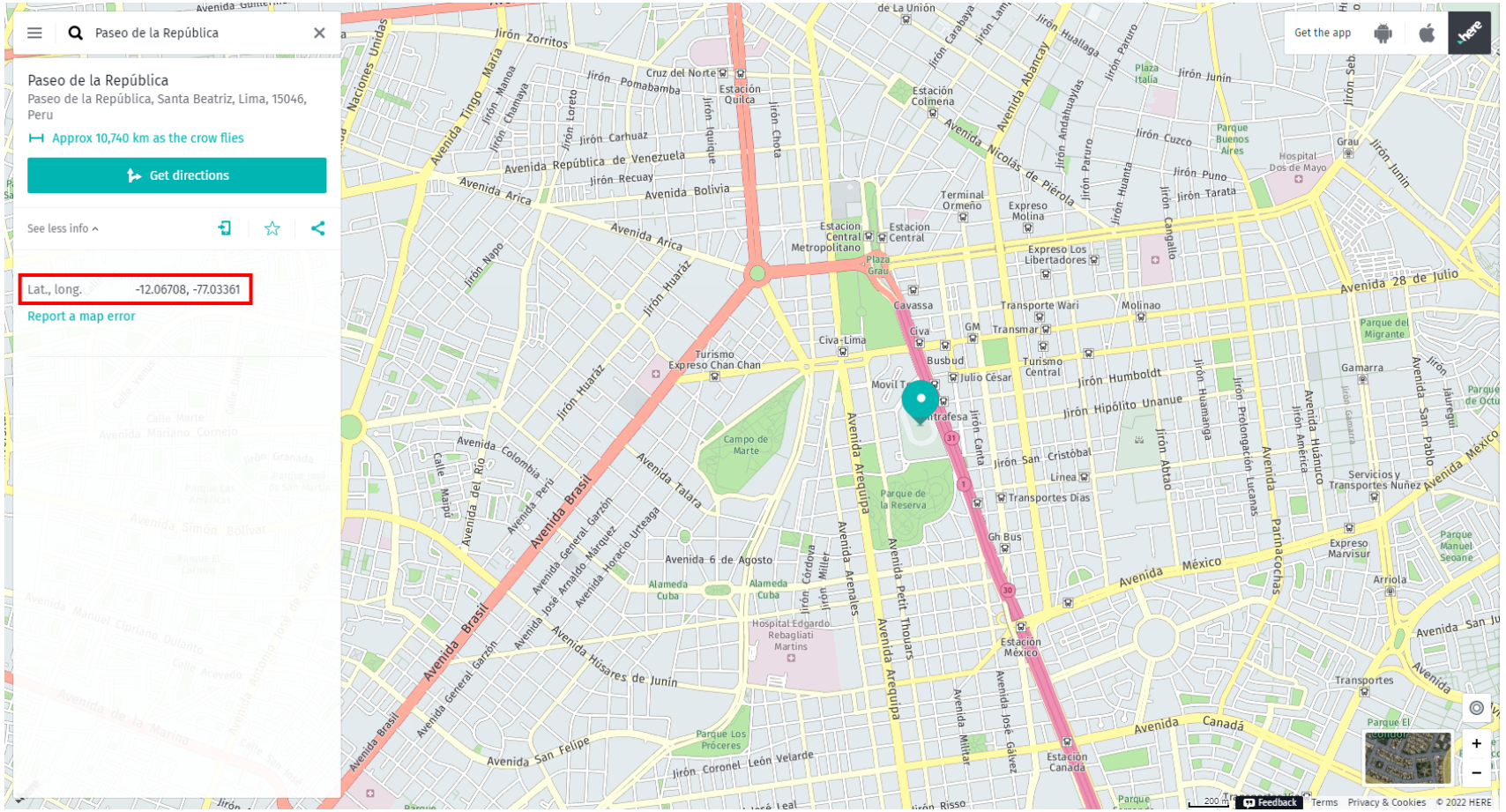
A geocoding procedure of many locations called batch geocoding.

In certain cases, geocoding by building's address can be problematic. A suggestion is to geocode by the place name (if it has one), e.g. Cathédrale Notre-Dame de Paris, 동대문 디자인 플라자, የኢትዮጵያ ብሔራዊ ሙዚየም, Catedral Metropolitana de la Ciudad de México, Akshardham etc.

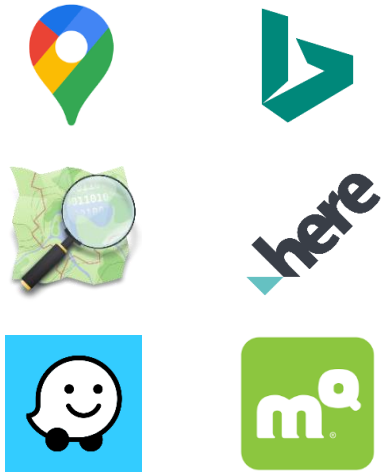
The domains of geocoding application: GIS Analysis, Geomarketing, IT, Logistics and many others.

Image: https://commons.wikimedia.org/wiki/File:Latitude_and_Longitude_of_the_Earth.svg
https://en.wikipedia.org/wiki/Spatial_reference_system accessed 18.04.2022

II. Geocode as a Novice
1) on the Internet : a Tiled Web Map service



The most commonly known TWM services possess a special searching field for locating either by an address (a place name) or coordinates.



https://wego.here.com/?map=-12.06708,-77.03361,15,normal&x=ep
https://en.wikipedia.org/wiki/Tiled_web_map accessed 18.04.2022

II. Geocode as a Novice
1) on the Internet : a web page

There are some websites that offer geocoding solutions online:

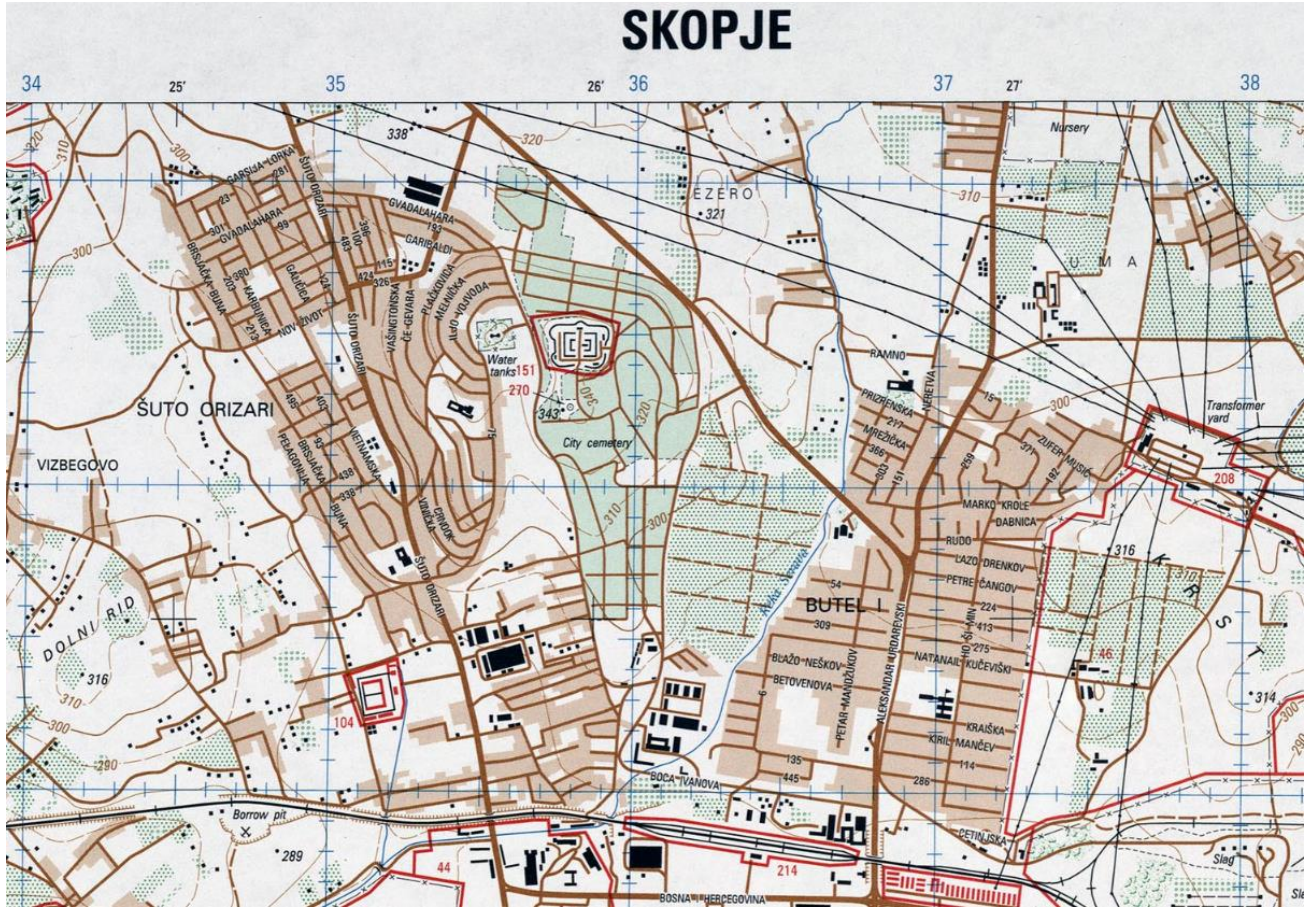
- https://geocode.localfocus.nl/
- https://geocode.xyz/
- https://www.gpsvisualizer.com/geocoder/
- https://www.geocod.io/upload/
- https://www.geoapify.com/tools/geocoding-online
- https://www.latlong.net/
- https://batchgeo.com/
- https://geoservices.tamu.edu/Services/ReverseGeocoding/BatchProcess/
- http://more.stevemorse.org/latlonbatch2.html?direction=forward
- and many others …

Many of them may need an API key, otherwise can be open.

The majority normally support batch geocoding (e.g. via uploading a CSV file).

II. Geocode as a Novice
1) on a Map : geographic coordinates grids

- A large scale (topographic) map or plan of a settlement is required
- Buildings on the map have to have numbers as well streets have to be signed
- A person needs to know how to determine the latitude and longitude of a point on the map
- It is nice to have geographic coordinates grids, otherwise, a person will need to do much calculus



Map Copyrights : http://www.vidiani.com/large-scale-detailed-topographical-map-skopje-city-with-roads-and-buildings/
https://gisgeography.com/latitude-longitude-coordinates/
https://en.wikipedia.org/wiki/Topographic_map accessed 18.04.2022

II. Geocode as an Advanced Beginner
2) with a spreadsheet : an offline pseudo geocoding with authoritative data in MS Excel

A simple workflow can look like:

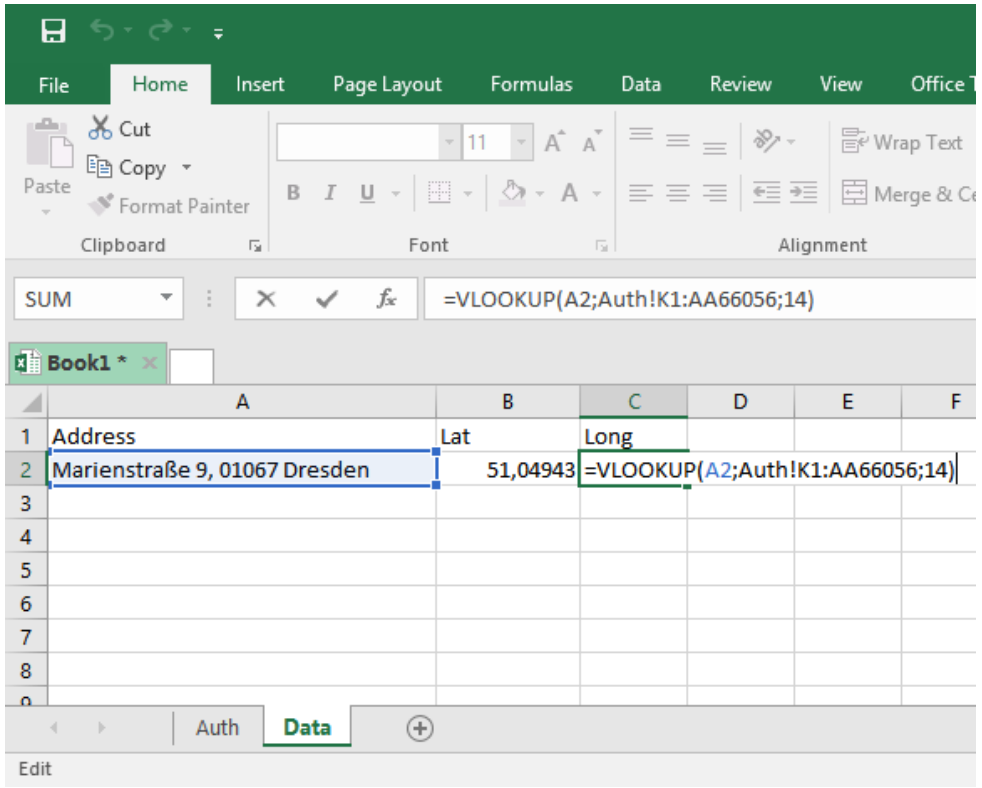
(1) Retrieve addresses from a credible data source, government open data

(2) Bring your data with authoritative data in one document

(3) Apply the VLOOKUP function

The data is reliable, the process is logical, but the result can be scarce.

For example, "Street" can be written by a user as a "Str.", "Str", "street", "STR.", "str." etc.



OpenDataPortal Dresden: https://opendata.dresden.de/informationsportal/#app/mainpage/Adressen

https://gis.stackexchange.com/questions/300461/reverse-geocoding-in-qgis

https://support.microsoft.com/en-us/office/vlookup-function-0bbc8083-26fe-4963-8ab8-93a18ad188a1 accessed 22.04.2022

II. Geocode as an Advanced Beginner
2) with a spreadsheet : an integrated solution

There are several approaches available to deploying a geocoding service:

(1) Use a finished solution:

- http://excelgeocodingtool.com/
- https://github.com/gramener/geocode-excel
- https://www.adventuresincre.com/product/a-cre-geocoding-excel-add-in/
- Power Map for MS Excel

(2) Program a solution by yourself (requires certain VBA knowledge):

- https://grindgis.com/software/microsoft-excel/geocoding-excel-and-google
- https://www.mkrgeo-blog.com/the-costless-way-to-geocoding-addresses-in-excel-part-3-bulk-data-geocoding-with-nominatim-and-others-geocoding-tools/

	A	B	C
1	ADDRESS:	Latitude	Longitude
2	350 5th Ave, New York, NY 10118	40.7482436	-73.9851073
3	233 S Wacker Dr, Chicago, IL 60606	41.8788792	-87.6358363
4	4790 W 16th St, Indianapolis, IN 46222	39.7903146	-86.2336611
5	400 Broad St, Seattle, WA 98109	47.6203953	-122.3493709
6	1001 Rose Bowl Dr, Pasadena, CA 91103	34.1606364	-118.1674865
7	Cēsu novads, Cēsis, Bērzaines iela 34	57.3124255	25.2481863
8	GVHV+J5 Ifran, Morocco	33.5290625	-5.1070625
9	GVHG+XP Ifran, Morocco	33.5299375	-5.1231875
10	10 New Oak Road, London, N2 8LN	51.5950356	-0.1749923
11	Trakt Węgierski 32A, 38-450 Dukla, Poland	49.553489	21.682327
12	Cergowska 5, 38-450 Dukla, Poland	49.554615	21.684869
13	إفران	33.5228062	-5.1109552
14	Viale Tevere, 7, 03100 Frosinone FR, Italy	41.6438455	13.3442056
15	Via Felice Cavallotti, 36b, 00152 Roma RM, Italy	41.8788684	12.4622387
16	Cara Lazara 38, Kraljevo 36000, Serbia	43.7241	20.68833
17	Topličin venac 9, Beograd 11000, Serbia	44.8161349	20.455482
18	Świętokrzyska 20, 25-406 Kielce, Poland	50.8803701	20.6477226
19	20, Markivtsi, Ivano-Frankivsk Oblast, Ukraine, 77470	48.8337987	24.8027619
20	12 Zelena St, Mukachevo, Zakarpattia Oblast, Ukraine, 89600	48.4503253	22.7050186
21	Debrecen, Csapó u. 24, 4024 Hungary	47.5314509	21.626959
22	Debrecen, Szoboszlói út 50, 4031 Hungary	47.5160122	21.6081057
23			

II. Geocode as a Competent
3) using GIS Software : QGIS

Starting from QGIS 3.20 the Nominatim Geocoder comes on board.
There are two features available:

(1) a Nominatim locator filter
(2) the "Batch Nominatim geocoder" processing tool for batch geocoding (converting addresses to coordinates). Placed in the Vector General of the Processing Toolbox.

Developer : @Mathieu Pellerin (https://github.com/nirvn)

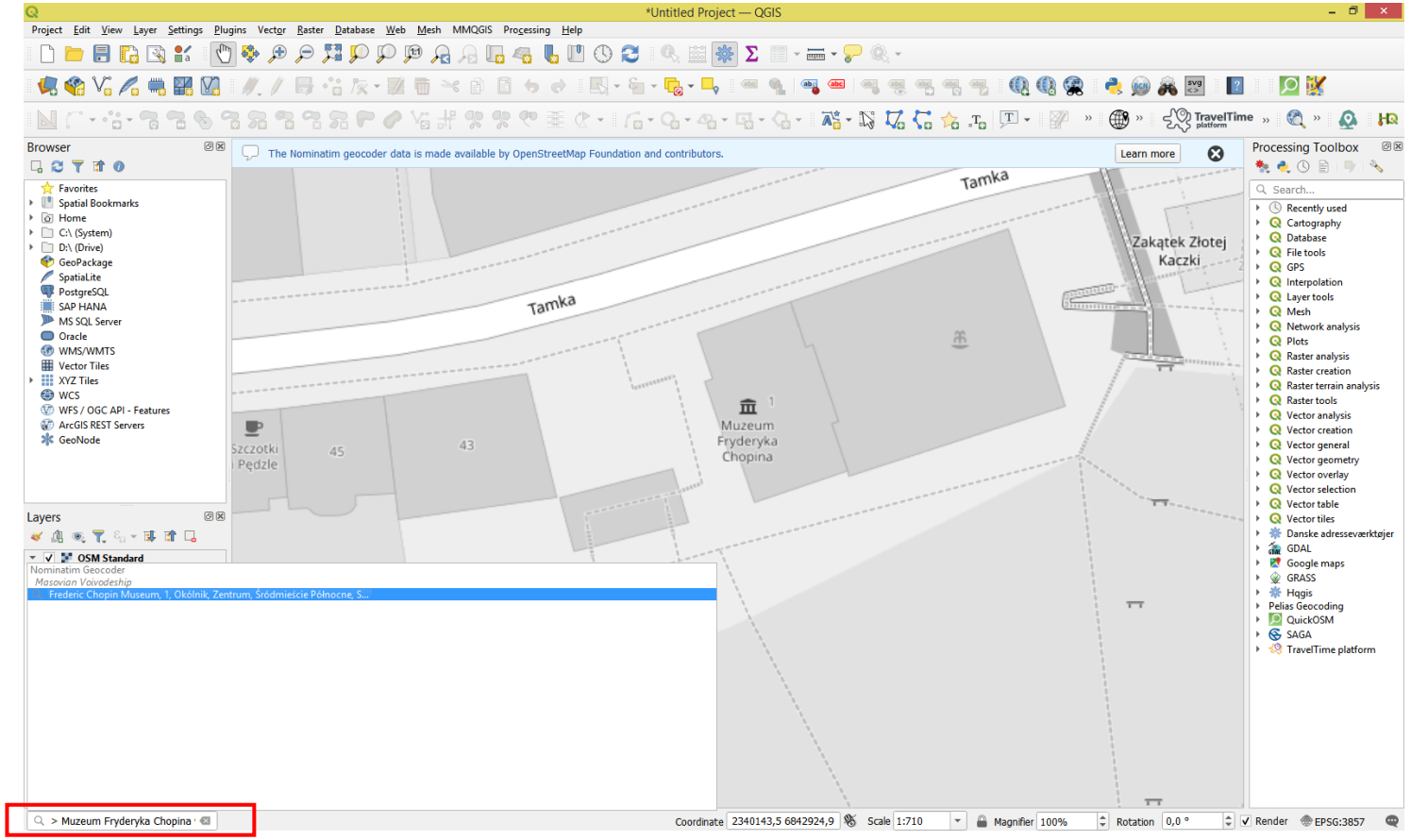
The Nominatim (https://nominatim.org/) is under the hood.

Nominatim is a tool to search OpenStreetMap data by name and address and to generate synthetic addresses of OpenStreetMap points (reverse geocoding).
No heavy uses (an absolute maximum of 1 request per second).
The daily limit is 86400 requests (1sec * 60 * 60 * 24).

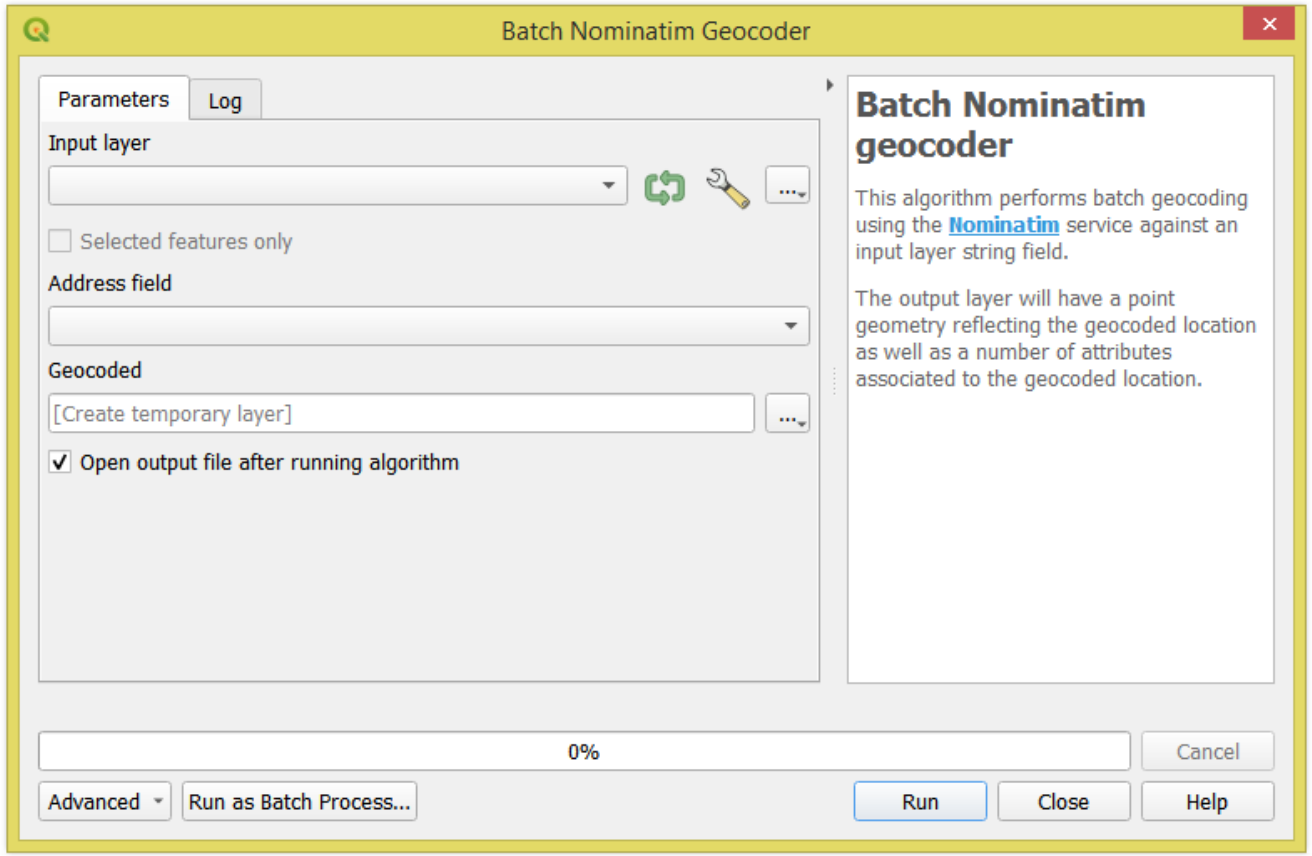
https://www.qgis.org/en/site/forusers/visualchangelog320/index.html#feature-nominatim-geocoder-integration
https://docs.qgis.org/latest/en/docs/user_manual/processing_algs/qgis/vectorgeneral.html#batch-nominatim-geocoder
accessed 18.04.2022

II. Geocode as a Competent 3) using GIS Software : QGIS

- The Nominatim locator filter is embedded into the QGIS locator bar widget (by default, a search bar in the bottom left corner **`Ctrl + K`**)
- For searches, use the prefix `>`
  `>Muzeum Fryderyka Chopina w Warszawie`
- Works also with coordinates
  `>52.236470, 21.022923`
- Similar to GeoCoding plugin, but it does not create a layer



II. Geocode as a Competent
3) using GIS Software : QGIS



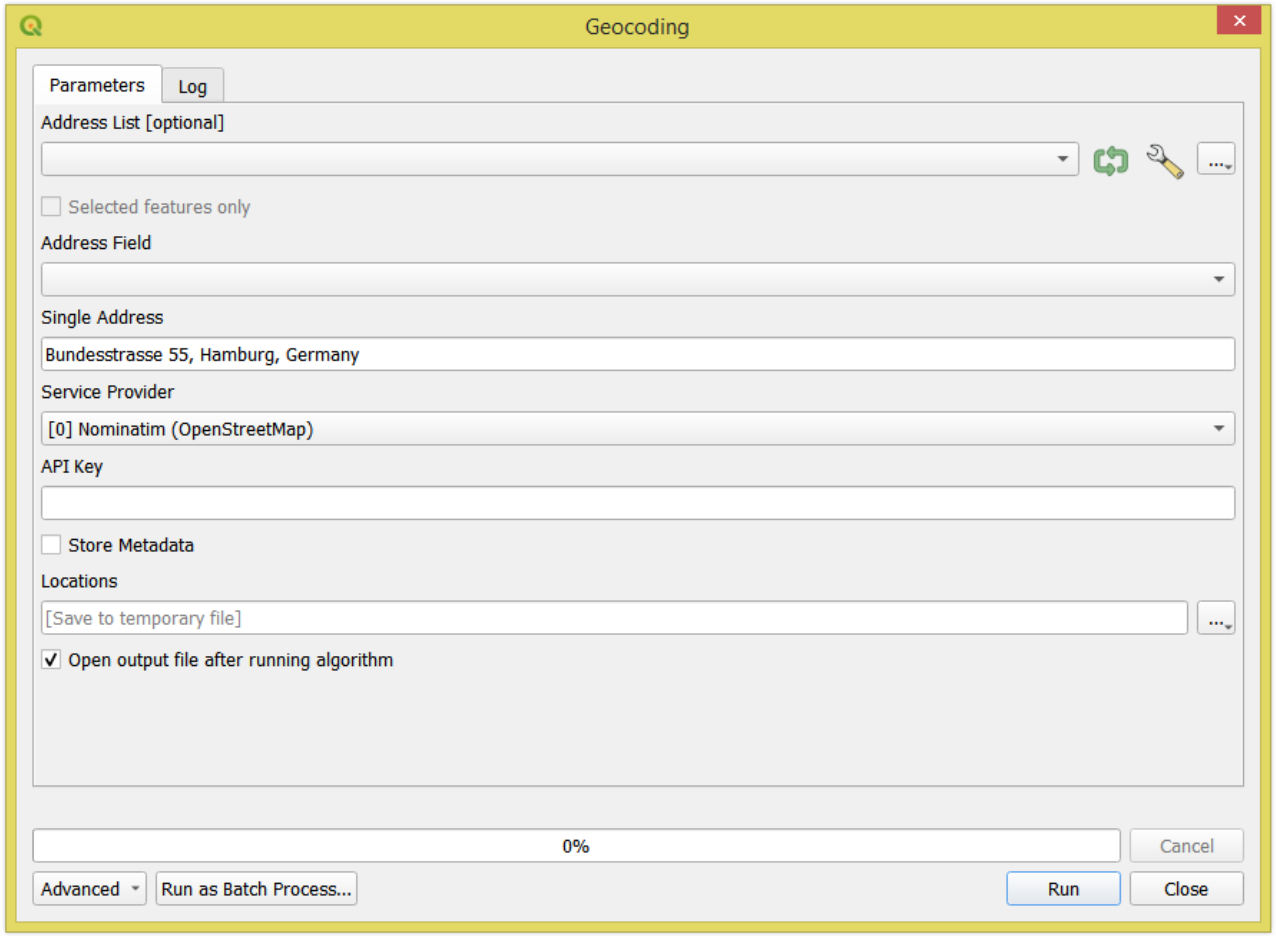
INPUT : a layer with a field that defines an address
OUTPUT : a point vector layer with original and several new fields

New Field(s)	Description
"osm_type"	reference to the OSM object
"display_name"	full comma-separated address
"place_id"	reference to the Nominatim internal database ID
"class", "type"	key and value of the main OSM tag
"road", "village", "city_district", "town", "city", "state", "country", "postcode"	address details

Q : What to do if you want more?

Simply saying: *the Nominatim with OpenStreetMap is not enough*

II. Geocode as a Competent
3) using add-ins in GIS Software



Another option is the "Geocoding" Tool from the SAGA provider.

It can be found in the SAGA's Import/Export – Web Services menu of the Processing Toolbox.

Contains five geocoding services: Nominatim, The Data Science Toolkit, Google Maps, Bing, and MapQuest.

https://saga-gis.sourceforge.io/saga_tool_doc/7.8.2/io_webservices_0.html accessed 18.04.2022

II. Geocode as a Competent
3) using a Plugin in GIS Software

QGIS Plugins that perform geocoding:
(searched by tags : geocode, geocoder, geocoding, address, locator)

GeoCoding

What3words Tools

MapTiler

TravelTime platform Plugin

Placekey - Address Matching and Entity Resolution

Hqgis

MMQGIS

TomTom Locator Filter

Pelias Geocoding

Nominatim Locator Filter

Google Maps Geocoder

world

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local

PDOK Locatieserver Locator Filter

Geosearch DK

Digitransit.fi Geocoder

geopunt4Qgis

Geokodowanie Adresów UUG GUGiK

Danish Address Tools

Estonian IN-ADS search

OS search for addresses

Gban

French Locator Filter

GeoBarcelona

BKG Geocoder

French Address

Fonctions SIGMOÉ

Gazetteer Berlin/Brandenburg

https://plugins.qgis.org/plugins/tags/geocode/, https://plugins.qgis.org/plugins/tags/geocoder/, https://plugins.qgis.org/plugins/tags/geocoding/, https://plugins.qgis.org/plugins/tags/address_2/ accessed 18.04.2022

26 QGIS Plugins that are available for geocoding : Part 1
(sorted by number of downloads)

#	Name	URLs	API key required	Downloads	Geocoder(s)	Batch	Reverse	Covered Area
1	MMQGIS	https://plugins.qgis.org/plugins/mmqgis/ https://michaelminn.com/linux/mmqgis/	no/yes	1.107.363	Nominatim, Google Maps, ESRI Server, US Census Bureau, NetToolKit	yes	yes	World
2	GeoCoding	https://plugins.qgis.org/plugins/GeoCoding/	no/yes	291.063	Nominatim, Google Maps	no	yes	World
3	MapTiler	https://plugins.qgis.org/plugins/qgis-maptiler-plugin/ https://www.maptiler.com/qgis-plugin/	yes	97.269	MapTiler Cloud API	no	yes	World
4	geopunt4Qgis	https://plugins.qgis.org/plugins/geopunt4Qgis/ https://www.geopunt.be/over-geopunt/faq/plug-in	no	94.293	Geopunt API provided by the Flemish government Geographical Portal Geopunt	yes	yes	Flanders
5	Geosearch DK	https://plugins.qgis.org/plugins/geosearch_dk/ https://dawadocs.dataforsyningen.dk/dok/api	no	41.477	DAWA's Datavask API	no	no	Denmark
6	Nominatim Locator Filter	https://plugins.qgis.org/plugins/nominatim_locator_filter/	no	25.643	Nominatim	no	yes	World
7	TravelTime platform Plugin	https://plugins.qgis.org/plugins/travel_time_platform_plugin/ https://docs.traveltime.com/qgis/about/reference-manual	yes	25.455	The TravelTime platform API	yes	yes	World
8	Hqgis	https://plugins.qgis.org/plugins/Hqgis/ https://developer.here.com/documentation/geocoding-search-api/dev_guide/index.html	yes	24.123	Here	yes	no	World
9	Google Maps Geocoder	https://plugins.qgis.org/plugins/google_maps_geocoder/ https://developers.google.com/maps/documentation/geocoding/	yes	24.121	Google Maps	yes	yes	World
10	French Locator Filter	https://plugins.qgis.org/plugins/french_locator_filter/ https://oslandia.gitlab.io/qgis/french_locator_filter/ https://adresse.data.gouv.fr/api-doc/adresse	no	19.140	Etalab's Adresse API provided by the La direction interministérielle du numérique (DINUM)	no	no	France

26 QGIS Plugins that are available for geocoding : Part 2
(sorted by number of downloads)

#	Name	URLs	API key required	Downloads	Geocoder(s)	Batch	Reverse	Covered Area
11	PDOK Locatieserver Locator Filter	https://plugins.qgis.org/plugins/pdok_locatieserver_locator_filter/ https://www.pdok.nl/pdok-locatieserver	no	16.969	PDOK Locatieserver	no	no	The Netherlands
12	Gban	https://plugins.qgis.org/plugins/gban/ https://adresse.data.gouv.fr/api-doc/adresse	no	8.705	Etalab's Adresse API provided by the La direction interministérielle du numérique (DINUM)	no	yes	France
13	Pelias Geocoding	https://plugins.qgis.org/plugins/PeliasGeocoding/	yes	8.588	Openrouteservice, Geocode Earth	yes	yes	World
14	French Address	https://plugins.qgis.org/plugins/french_address/ https://adresse.data.gouv.fr/api-doc/adresse	no	8.167	Etalab's Adresse API provided by the La direction interministérielle du numérique (DINUM)	no	yes	France
15	Geokodowanie Adresów UUG GUGiK	https://plugins.qgis.org/plugins/geokodowanie_adresow/ http://services.gugik.gov.pl/uug/	no	5.593	Uniwersalna Usługa Geokodowania (UUG) provided by the Główny Urząd Geodezji i Kartografii (GUGiK)	yes	no	Poland
16	BKG Geocoder	https://gdz.bkg.bund.de/index.php/default/qgis-bkg-geocoder.html https://plugins.qgis.org/plugins/bkggeocoder/	yes	3.484	BKG Geocoder provided by the Bundesamt für Kartographie und Geodäsie	yes	yes	Germany
17	GeoBarcelona	https://plugins.qgis.org/plugins/geobarcelona/ https://w33.bcn.cat/GeoBcn	no	2.754	GeoBcn provided by the l'Ajuntament de Barcelona	no	no	Barcelona
18	Danish Address Tools	https://plugins.qgis.org/plugins/AddressToolsDK/ https://dawadocs.dataforsyningen.dk/dok/api	no	2.066	DAWA's Datavask API	yes	no	Denmark
19	Fonctions SIGMOÉ	https://plugins.qgis.org/plugins/SgmExpressionFunctions/ https://adresse.data.gouv.fr/api-doc/adresse	no	1.868	Etalab's Adresse API provided by the La direction interministérielle du numérique (DINUM)	yes	yes	France

26 QGIS Plugins that are available for geocoding : Part 3
(sorted by number of downloads)

#	Name	URLs	API key required	Downloads	Geocoder(s)	Batch	Reverse	Covered Area
20	OS search for addresses	https://plugins.qgis.org/plugins/addresssearch/ https://osdatahub.os.uk/	yes	1.622	OS Data Hub Place API	no	no	The UK
21	TomTom Locator Filter	https://plugins.qgis.org/plugins/tomtom_locator_filter/ https://developer.tomtom.com/search-api/documentation/product-information/introduction	yes	1.106	TomTom's Search API	no	yes	World
22	Digitransit.fi Geocoder	https://digitransit.fi/en/developers/apis/2-geocoding-api/ https://plugins.qgis.org/plugins/QGISDigitransitGeocoding-master/	no	1.043	Digitransit.fi geocoding API	no	no	Finnland
23	Placekey - Address Matching and Entity Resolution	https://plugins.qgis.org/plugins/placekey/ https://www.placekey.io/	yes	871	The Placekey API	yes	yes	The Netherlands The US, Canada
24	What3words Tools	https://plugins.qgis.org/plugins/what3words/ https://developer.what3words.com/tools/gis-extensions/qgis	yes	375	what3words API	yes	yes	World
25	Gazetteer Berlin/Brandenburg	https://plugins.qgis.org/plugins/qgs-gazetteer-bb/ https://search.geobasis-bb.de/	no	328	Search API provided by the Landesvermessung und Geobasisinformation Brandenburg	no	no	Berlin and Brandenburg
26	Estonian IN-ADS search	https://plugins.qgis.org/plugins/in_ads/ https://geoportaal.maaamet.ee/eng/Services/In-ADS-p660.html	no	234	In-ADS API	no	no	Estonia

II. Geocode as a Proficient
4) with GIS Software API : PyQGIS

This snippet of code can be used for geocoding with the "Batch Nominatim geocoder" processing algorithm using PyQGIS

```
import processing

layer = qgis.utils.iface.activeLayer()

result = processing.run("native:batchnominatimgeocoder",
            {'INPUT': layer, 'FIELD': "address", 'OUTPUT':
'memory:'})

QgsProject.instance().addMapLayer(result['OUTPUT'])
```

II. Geocode as a Proficient
4) with GIS Software API : PyQGIS

Surprisingly but starting from QGIS 3.18 already had two embedded API geocoder classes:

- `QgsNominatimGeocoder`: https://qgis.org/pyqgis/master/core/QgsNominatimGeocoder.html
- `QgsGoogleMapsGeocoder`: https://qgis.org/pyqgis/master/core/QgsGoogleMapsGeocoder.html

Also developed by @Mathieu Pellerin (https://github.com/nirvn).

Keep in mind : To deploy the Google Maps geocoding API's class the `apiKey` argument must be provided.

https://www.qgis.org/en/site/forusers/visualchangelog318/index.html#feature-nominatim-geocoder-api accessed 19.04.2022

II. Geocode as a Proficient
4) with GIS Software API : PyQGIS

`QgsNominatimGeocoder` **`QgsGoogleMapsGeocoder`**

Methods in common:

`appendedFields, flags, geocodeFeature, geocodeString, jsonToResult, requestUrl, setEndpoint, wkbType`

Unique methods:

`countryCodes, endpoint, requestsPerSecond, setCountryCodes, setRequestsPerSecond`

Unique methods:

`apiKey, region, setApiKey, setRegion`

Both classes can be imported from the `qgis.core`

```
from qgis.core import QgsNominatimGeocoder
from qgis.core import QgsGoogleMapsGeocoder
```

The usage of several additional classes may be useful/required :

- `QgsGeocoderContext` : https://api.qgis.org/api/classQgsGeocoderContext.html
- `QgsCoordinateTransformContext` : https://api.qgis.org/api/classQgsCoordinateTransformContext.html
- `QgsGeocoderLocatorFilter` : https://api.qgis.org/api/classQgsGeocoderLocatorFilter.html
- `QgsAbstractGeocoderLocatorFilter` : https://api.qgis.org/api/classQgsAbstractGeocoderLocatorFilter.html

II. Geocode as a Proficient
4) with GIS Software API : PyQGIS

A working example of how to use each of the geocoder class

QgsNominatimGeocoder

```
from qgis.core import (QgsNominatimGeocoder,
                       QgsGeocoderContext,
                       QgsCoordinateTransformContext)

address = 'Trachenberger Str. 38, 01129 Dresden, Germany'

geocoder = QgsNominatimGeocoder()
context = QgsGeocoderContext(QgsCoordinateTransformContext())
output = geocoder.geocodeString(address, context,
feedback=None)

methods_for_geocoder_result = [ 'additionalAttributes', 'crs',
'geometry', 'isValid', 'description', 'error', 'group',
'identifier' ]

for out in output:
    for method in methods_for_geocoder_result:
        print(method, getattr(out, method)())
```

QgsGoogleMapsGeocoder

```
from qgis.core import (QgsGoogleMapsGeocoder,
                       QgsGeocoderContext,
                       QgsCoordinateTransformContext)

address = 'Trachenberger Str. 38, 01129 Dresden, Germany'

geocoder = QgsGoogleMapsGeocoder(apiKey='***')
context = QgsGeocoderContext(QgsCoordinateTransformContext())
output = geocoder.geocodeString(address, context,
feedback=None)

methods_for_geocoder_result = [ 'additionalAttributes', 'crs',
'geometry', 'isValid', 'description', 'error', 'group',
'identifier' ]

for out in output:
    for method in methods_for_geocoder_result:
        print(method, getattr(out, method)())
```

II. Geocode as a Proficient
4) with GIS Software API : PyQGIS

The Nominatim geocoder can sometimes be a bit complex ...

QgsNominatimGeocoder

```
additionalAttributes {'city': 'Dresden', 'city_district': 'Pieschen', 'class': 'tourism',
'country': 'Germany', 'display_name': 'Straßenbahnmuseum Dresden e.V., Trachenberger Straße,
Pieschen-Nord/Trachenberge, Pieschen, Dresden, Saxony, 01129, Germany', 'osm_type': 'node',
'place_id': '1319654', 'postcode': '01129', 'road': 'Trachenberger Straße', 'state':
'Saxony', 'type': 'museum'}
crs <QgsCoordinateReferenceSystem: EPSG:4326>
geometry <QgsGeometry: Point (13.72919160000000005 51.08626329999999882)>
isValid True
description
error
group Saxony
identifier Straßenbahnmuseum Dresden e.V., Trachenberger Straße, Pieschen-Nord/Trachenberge,
Pieschen, Dresden, Saxony, 01129, Germany
```

```
additionalAttributes {'city': 'Dresden', 'city_district': 'Pieschen', 'class': 'building',
'country': 'Germany', 'display_name': '38, Trachenberger Straße, Pieschen-Nord/Trachenberge,
Pieschen, Dresden, Saxony, 01129, Germany', 'osm_type': 'way', 'place_id': '106533175',
'postcode': '01129', 'road': 'Trachenberger Straße', 'state': 'Saxony', 'type':
'industrial'}
crs <QgsCoordinateReferenceSystem: EPSG:4326>
geometry <QgsGeometry: Point (13.72950708533253916 51.08659294999999645)>
isValid True
description
error
group Saxony
identifier 38, Trachenberger Straße, Pieschen-Nord/Trachenberge, Pieschen, Dresden, Saxony,
01129, Germany
```

QgsGoogleMapsGeocoder

```
additionalAttributes {'administrative_area_level_1':
'Sachsen', 'country': 'Deutschland',
'formatted_address': 'Trachenberger Str. 38, 01129
Dresden, Deutschland', 'locality': 'Dresden',
'location_type': 'ROOFTOP', 'place_id':
'ChIJMXG36v_OCUcRcu7kfljCywM', 'postal_code': '01129',
'route': 'Trachenberger StraÃŸe', 'street_number':
'38'}
crs <QgsCoordinateReferenceSystem: EPSG:4326>
geometry <QgsGeometry: Point (13.7295777999999995
51.08656100000000322)>
isValid True
description
error
group Sachsen
identifier Trachenberger Str. 38, 01129 Dresden,
Deutschland
```

P.S. To avoid ambiguity for Nominatim result use a filter :

```
out.additionalAttributes()['class'] == 'building'
```


https://gis.stackexchange.com/questions/427212/geocoding-address-in-attribute-table-with-pyqgis

II. Geocode as a Proficient
4) using a Geocoding API

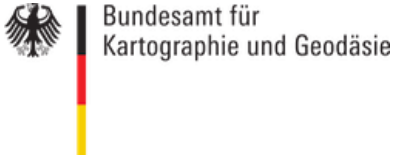
There are plenty of geocoding APIs (geocoders) maintained by the mapping services:

- Google Maps
  https://developers.google.com/maps/documentation/geocoding
- ArcGIS
  https://developers.arcgis.com/documentation/mapping-apis-and-services/search/
- Bing Maps
  https://docs.microsoft.com/en-us/bingmaps/rest-services/locations/?redirectedfrom=MSDN
- TomTom
  https://developer.tomtom.com/products/places-api
- HERE
  https://developer.here.com/c/geocoding
- MapBox
  https://docs.mapbox.com/playground/geocoding/
- MapTiler
  https://www.maptiler.com/cloud/geocoding/
- Precisely
  https://www.precisely.com/product/precisely-spectrum-geocoding/spectrum-geocoding
- OpenCage
  https://opencagedata.com/api
- OpenWeather
  https://openweathermap.org/api/geocoding-api
- Positionstack
  https://positionstack.com/
- MapLarge
  https://www.maplarge.com/developer/geocoderapi

https://en.wikipedia.org/wiki/API
https://gisgeography.com/geocoders/ accessed 23.04.2022

II. Geocode as a Proficient
4) using a Geocoding API



There are also some free geocoding APIs (geocoders):

- Nominatim
  https://nominatim.org/
- Gisgraphy
  https://www.gisgraphy.com/index.php
- GeoNames
  http://www.geonames.org/export/
- MapQuest
  https://developer.mapquest.com/documentation/open/
- API Adresse
  https://adresse.data.gouv.fr/api-doc
- BKG Geocoder
  https://gdz.bkg.bund.de/index.php/default/webanwendungen/bkg-geocoder.html
- Census Geocoder
  https://www.census.gov/programs-surveys/geography/technical-documentation/complete-technical-documentation/census-geocoder.html

However, keep in mind, that many "not free" geocoding APIs have "a free" subscription plan.

It may be limited in terms of the number of requests per day/per second, the purpose of usage, level of support from the provider, variety of response formats, CORS restriction, IP restrictions, number of end-users and other restraints.

However, it might be enough for your personal (testing) purposes.

Also, pay attention to the Terms of Use and Privacy Policies, and the License Restrictions.

https://stackoverflow.com/questions/8180623/which-are-the-best-geo-coding-apis-available-for-free
https://en.wikipedia.org/wiki/Cross-origin_resource_sharing accessed 23.04.2022

II. Geocode as an Expert
5) by means of Python : GeoPy

Many packages available on the The Python Package Index (PyPI):
https://pypi.org/search/?q=geocoding

- 295 projects for "geocoding"
- 50 projects for "geocoding" with the "Production/Stable" Status

A personal suggestion : GeoPy
is a Python client for several popular geocoding web services.
Documentation : https://geopy.readthedocs.io/en/stable/

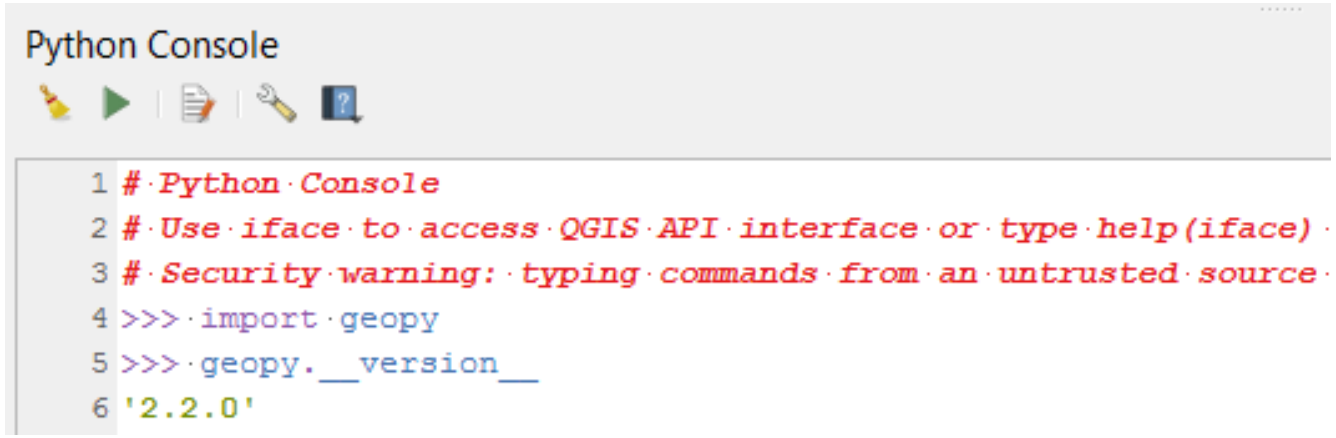
II. Geocode as an Expert
5) by means of Python : GeoPy

Advantages:

- Well documented
- Compatible with Pandas
- All geocoders can be deployed with the asyncio Python library, to make them work asynchronous, by default they work synchronous
- The GeoPy embraces a tremendous list of geolocation services : AlgoliaPlaces, ArcGIS, AzureMaps, Baidu, BaiduV3, BANFrance, Bing, DataBC, GeocodeEarth, GeocodeFarm, Geocodio, Geolake, GeoNames, GoogleV3, HERE, HEREv7, IGNFrance, MapBox, MapQuest, MapTiler, OpenCage, OpenMapQuest, Nominatim, Pelias, Photon, PickPoint, LiveAddress, TomTom, What3Words, and What3WordsV3
- Moreover, for each geocoder it will be always a parsed geocoder response with: an address, latitude, longitude, and raw output.
- Can be used for calculating geodesic distance between two points using multiple popular ellipsoidal models
- **Can be integrated into QGIS**

https://docs.python.org/3/library/asyncio.html accessed 20.04.2022

II. Geocode as an Expert
5) by means of Python : QGIS meets GeoPy



- GeoPy (after installation), like many other Python Packages, can be called in QGIS 3
- It can be used for creating own functions for geocoding, e.g. in the Function Editor

https://docs.qgis.org/latest/en/docs/user_manual/expressions/expression.html#function-editor
https://www.giscourse.com/install-qgis-through-osgeo4w/
https://landscapearchaeology.org/2018/installing-python-packages-in-qgis-3-for-windows/
https://gis.stackexchange.com/questions/141320/installing-3rd-party-python-libraries-for-qgis-on-windows
https://www.lutraconsulting.co.uk/blog/2016/03/02/installing-third-party-python-modules-in-qgis-windows/

II. Geocode as an Expert
5) by means of Python : QGIS carries requests

There is another useful Python Package which is already included in QGIS.

Requests: HTTP for Humans™ - it is an elegant and simple HTTP library for Python.

Documentation : https://docs.python-requests.org/en/latest/

For example: a request to the Nominatim geocoder

```
r = requests.get('https://nominatim.openstreetmap.org/search?<params>')
```

https://nominatim.org/release-docs/latest/api/Search/ accessed 27.04.2022

II. Geocode as a God : ☺

Use Pelias locally (on your machine or your own server) inside a Docker container image.

Pelias is a geocoder powered completely by open data, available freely to everyone.

A Docker container image is a lightweight, standalone, executable package of software that includes everything needed to run an application: code, runtime, system tools, system libraries and settings.

https://pelias.io/
https://github.com/pelias/docker
https://www.docker.com/
https://en.wikipedia.org/wiki/Server_(computing) accessed 28.04.2022

III. Reverse geocoding in QGIS

There are several ways exist to get an address from a tuple of coordinates :

1. Use a Plugin
2. Join address to the input layer by nearest from an authoritative data source (i.e. open data from the government).
   The "Join attributes by nearest" geoalgorithm placed in the Vector General of the Processing Toolbox.
   Alternatively there is a special function called `overlay_nearest()`
3. Write a custom function for reverse geocoding
   with GeoPy/requests in the Function Editor

https://docs.qgis.org/latest/en/docs/user_manual/processing_algs/qgis/vectorgeneral.html#join-attributes-by-nearest
https://docs.qgis.org/latest/en/docs/user_manual/expressions/functions_list.html#overlay-nearest
https://gis.stackexchange.com/questions/300461/reverse-geocoding-in-qgis
https://gis.stackexchange.com/questions/390143/reverse-geocoding-in-qgis-graphical-modeller
https://gis.stackexchange.com/questions/189807/reverse-geocoding-with-qgis accessed 26.04.2022

IV. Time to try geocoding in QGIS

There is a CSV file called "geocoding.csv" (encoded in UTF-8) with some information about 10 museums taken randomly around the world, see the image below.

geocoding.csv *

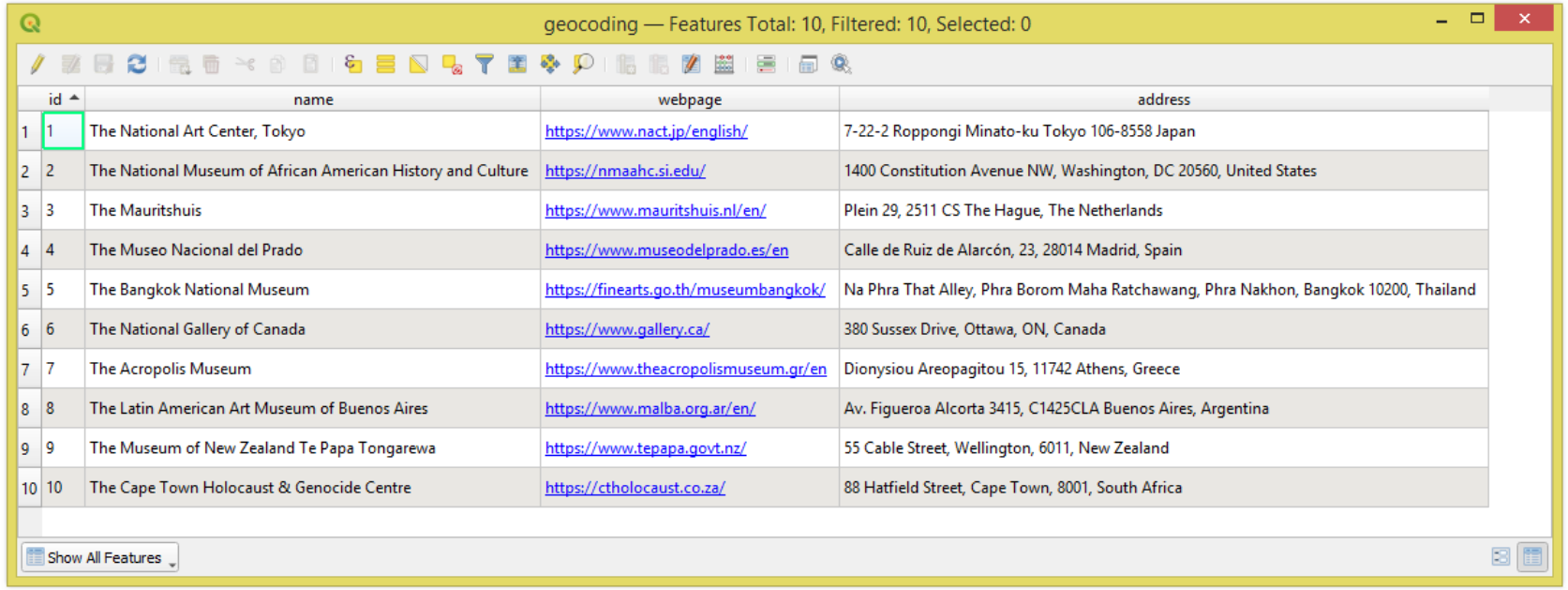
	A	B	C	D
1	id	name	webpage	address
2	1	The National Art Center, Tokyo	https://www.nact.jp/english/	7-22-2 Roppongi Minato-ku Tokyo 106-8558 Japan
3	2	The National Museum of African American History and Culture	https://nmaahc.si.edu/	1400 Constitution Avenue NW, Washington, DC 20560, United States
4	3	The Mauritshuis	https://www.mauritshuis.nl/en/	Plein 29, 2511 CS The Hague, The Netherlands
5	4	The Museo Nacional del Prado	https://www.museodelprado.es/en	Calle de Ruiz de Alarcón, 23, 28014 Madrid, Spain
6	5	The Bangkok National Museum	https://finearts.go.th/museumbangkok/	Na Phra That Alley, Phra Borom Maha Ratchawang, Phra Nakhon, Bangkok 10200, Thailand
7	6	The National Gallery of Canada	https://www.gallery.ca/	380 Sussex Drive, Ottawa, ON, Canada
8	7	The Acropolis Museum	https://www.theacropolismuseum.gr/en	Dionysiou Areopagitou 15, 11742 Athens, Greece
9	8	The Latin American Art Museum of Buenos Aires	https://www.malba.org.ar/en/	Av. Figueroa Alcorta 3415, C1425CLA Buenos Aires, Argentina
10	9	The Museum of New Zealand Te Papa Tongarewa	https://www.tepapa.govt.nz/	55 Cable Street, Wellington, 6011, New Zealand
11	10	The Cape Town Holocaust & Genocide Centre	https://ctholocaust.co.za/	88 Hatfield Street, Cape Town, 8001, South Africa

Each address was taken from a museum's official page.

IV. Time to try geocoding in QGIS

Now let's geocode this CSV file with the "Batch Nominatim geocoder" processing tool. And then explore/assess the results.

To each record, it will be referred by its "id".



	id	name	webpage	address
1	1	The National Art Center, Tokyo	https://www.nact.jp/english/	7-22-2 Roppongi Minato-ku Tokyo 106-8558 Japan
2	2	The National Museum of African American History and Culture	https://nmaahc.si.edu/	1400 Constitution Avenue NW, Washington, DC 20560, United States
3	3	The Mauritshuis	https://www.mauritshuis.nl/en/	Plein 29, 2511 CS The Hague, The Netherlands
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7	7	The Acropolis Museum	https://www.theacropolismuseum.gr/en	Dionysiou Areopagitou 15, 11742 Athens, Greece
8	8	The Latin American Art Museum of Buenos Aires	https://www.malba.org.ar/en/	Av. Figueroa Alcorta 3415, C1425CLA Buenos Aires, Argentina
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10	10	The Cape Town Holocaust & Genocide Centre	https://ctholocaust.co.za/	88 Hatfield Street, Cape Town, 8001, South Africa

Be attentive to bring the CSV file with the UTF-8 encoding.

Double check it via Properties > Source > Data source encoding.

Inspecting the results after geocoding in QGIS

id	Result description	Failure : Data from the original source	Success : Data from OSM	Better approach : geocode by name
1	No result – 0%	7-chōme-22-2 Roppongi, Minato City, Tokyo 106-8558, Japan	The National Art Center, Roppongi 7-chome, Roppongi, Azabu, Minato, Tokyo, 106-0033, Japan https://nominatim.openstreetmap.org/ui/details.html?osmtype=W&osmid=136048451&class=building	The National Art Center, Tokyo
2	Done – 100%	-	-	NMAAHC
3	No result – 0%	Plein 29, 2511 CS The Hague, The Netherlands	Plein 29, 2511CS The Hague, The Netherlands https://nominatim.openstreetmap.org/ui/details.html?osmtype=N&osmid=2718100253&class=place	The Mauritshuis
4	Biased – 40% 35 km away in Meco	Calle de Ruiz de Alarcón, 23, 28014 Madrid, Spain	Calle Ruiz de Alarcón, 23, 28014 Madrid, Spain https://nominatim.openstreetmap.org/ui/details.html?osmtype=R&osmid=7726080&class=tourism	Museo del Prado
5	No result – 0%	Na Phrathat Road, Grand Palace sub district, Phra Nakorn district, Bangkok 10200, Thailand	Bangkok National Museum, Na Phra That Road, Tha Pra Chan, Phra Borom Maha Ratchawang Subdistrict, Phra Nakhon District, Bangkok, 10200, Thailand https://nominatim.openstreetmap.org/ui/details.html?osmtype=W&osmid=178329971&class=tourism	Bangkok National Museum
6	Done – 100%	-	-	National Gallery of Canada
7	Done – 100%	-	-	Acropolis Museum
8	Biased – 60% 23 km away in Castelar	Av. Figueroa Alcorta 3415 C1425CLA Buenos Aires, Argentina	Museo de Arte Latinoamericano de Buenos Aires, 3415, Avenida Presidente Figueroa Alcorta, Barrio Parque, Palermo, Buenos Aires, Comuna 14, Autonomous City of Buenos Aires, C1425CLA, Argentina https://nominatim.openstreetmap.org/ui/details.html?osmtype=W&osmid=23621021&class=tourism	Museo de Arte Latinoamericano de Buenos Aires
9	Done – 100%	-	-	Te Papa
10	Biased – 90% 60 m away	88 Hatfield Street, Cape Town, 8001, South Africa	Cape Town Holocaust Centre, Saint Johns Road, City Centre, Cape Town, City of Cape Town, Western Cape, 8001, South Africa https://nominatim.openstreetmap.org/ui/details.html?osmtype=W&osmid=203346850&class=tourism	Cape Town Holocaust Centre

Suggestions for Geocoding in QGIS with the "Batch Nominatim geocoder" processing tool

- Geocoding by POI's name (if it has one) can be much more robust
- An address from the official resource does not particularly mean that it is a valid address for Nominatim/OSM
- Better to double-check doubtful addresses in the Nominatim: https://nominatim.openstreetmap.org/ui/search.html
- Tiny things matter
- Expect that there can be poor as well as empty outputs

V. Time to try geocoding with GeoPy

There is a CSV file called "geocoding.csv" (encoded in UTF-8) with some information about 10 museums taken randomly around the world, see the image below.

geocoding.csv *

	A	B	C	D
1	id	name	webpage	address
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3	2	The National Museum of African American History and Culture	https://nmaahc.si.edu/	1400 Constitution Avenue NW, Washington, DC 20560, United States
4	3	The Mauritshuis	https://www.mauritshuis.nl/en/	Plein 29, 2511 CS The Hague, The Netherlands
5	4	The Museo Nacional del Prado	https://www.museodelprado.es/en	Calle de Ruiz de Alarcón, 23, 28014 Madrid, Spain
6	5	The Bangkok National Museum	https://finearts.go.th/museumbangkok/	Na Phra That Alley, Phra Borom Maha Ratchawang, Phra Nakhon, Bangkok 10200, Thailand
7	6	The National Gallery of Canada	https://www.gallery.ca/	380 Sussex Drive, Ottawa, ON, Canada
8	7	The Acropolis Museum	https://www.theacropolismuseum.gr/en	Dionysiou Areopagitou 15, 11742 Athens, Greece
9	8	The Latin American Art Museum of Buenos Aires	https://www.malba.org.ar/en/	Av. Figueroa Alcorta 3415, C1425CLA Buenos Aires, Argentina
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11	10	The Cape Town Holocaust & Genocide Centre	https://ctholocaust.co.za/	88 Hatfield Street, Cape Town, 8001, South Africa

Each address was taken from a museum's official page.

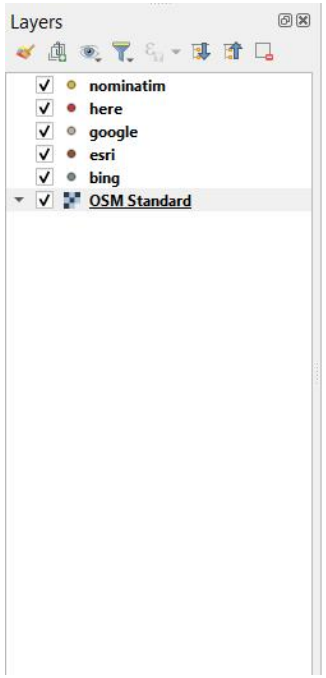
V. Time to try geocoding with GeoPy

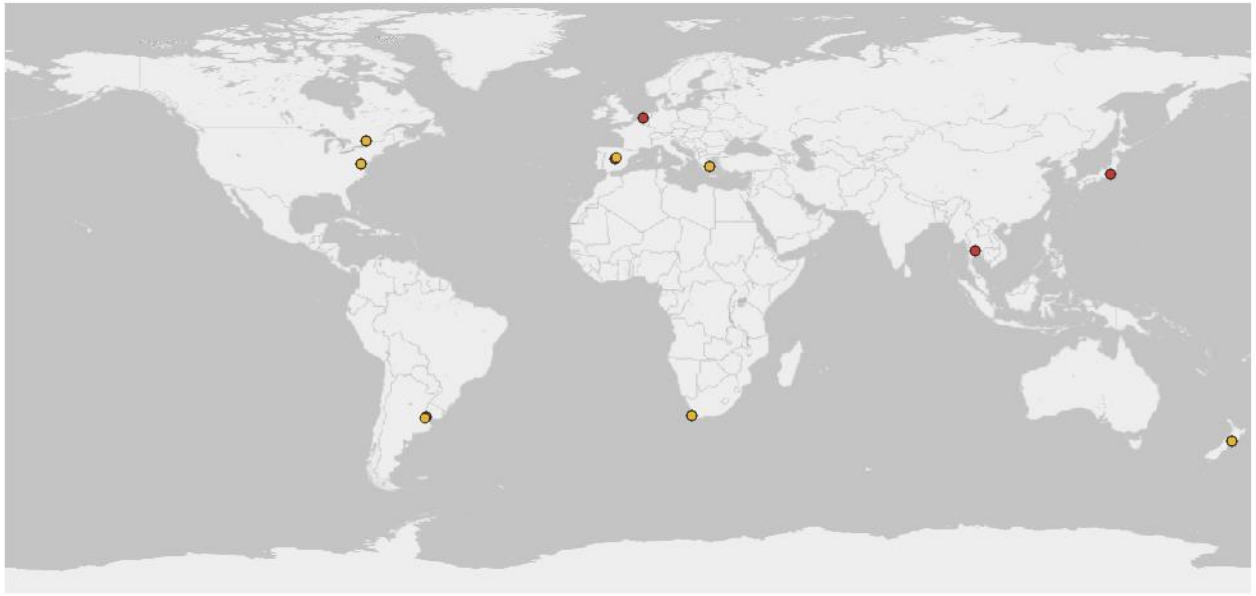
Now let's geocode this CSV file with the GeoPy using five geocoders: ArcGIS, Bing, GoogleV3, Here, and Nominatim.

And then explore/assess each result in QGIS. To each record, it will be referred by its "id".

The initial CSV file was read as a DataFrame by means of pandas.

Afterwards gocoder was applied, and then each DataFrame was exported again into a new CSV file. To be able to import it as Delimited Text Layer in QGIS.





https://pandas.pydata.org/

https://peterhaas-me.medium.com/how-to-geocode-with-python-and-pandas-4cd1d717d3f7 accessed 27.04.2022

Inspecting the results after geocoding with GeoPy

id	ESRI	Bing	GoogleV3	Here	Nominatim
1	yes	yes	yes	yes/no	no
2	yes	yes	yes/no	yes/no	yes
3	yes	yes	yes	yes	no
4	yes	yes	yes	yes	yes
5	no	no	no	no	no
6	yes	yes	yes	yes/no	yes
7	yes/no	yes	yes	yes/no	yes
8	yes	yes/no	yes	yes	no
9	yes	yes/no	yes	yes/no	yes
10	no	no	no	no	no

yes : a good result, yes/no : not enough to be good, no : a bad or no result

https://en.wikipedia.org/wiki/Esri accessed 28.04.2022

Suggestions for Geocoding with GeoPy

- Geocoding by POI's name (if it has one) can be much more robust
- The story with Tiled Web Map services should not repeat : Geocoder from Google Maps is not the only one solution, there are many good others
- Choosing a Geocoder can be a subjective topic : one can be good in Slovenia, but really bad in Jamaica, and vise versa
- Expect that there can be poor as well as empty outputs
- Perhaps a combination of proprietary and open source solutions can be the best in terms of costs and quality
- Rounding of coordinates can be useful using the `round` function (https://docs.python.org/3/library/functions.html#round). Everything that goes after the six digit is not necessary

https://en.wikipedia.org/wiki/Point_of_interest
https://gis.stackexchange.com/questions/8650/measuring-accuracy-of-latitude-and-longitude/8655#8655 accessed 26.04.2022

Thank you for your attention!

Questions ?

Suggestions !

Comments …

References

- https://en.wikipedia.org/wiki/Address_geocoding
- https://en.wikipedia.org/wiki/Reverse_geocoding
- https://en.wikipedia.org/wiki/Address
- https://en.wikipedia.org/wiki/World_Geodetic_System
- https://docs.mapbox.com/api/search/geocoding/
- https://opencagedata.com/api
- https://cybergibbons.com/security-2/why-what3words-is-not-suitable-for-safety-critical-applications/